# COMPARISON OF THE ACCEPTABILITY OF SELECTED SWEATERS MADE OF MAN-MADE FIBERS FROM DIFFERENT TYPES OF YARNS

by

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# INTRODUCTION

Sweaters made of wool yarns dominated the sweater industry until about ten years ago when man-made fibers came into use. Although wool is now being replaced it is still used as the standard in determining the desired characteristics of yarns for sweaters. As yet, not a single man-made fiber has all the important characteristics of wool, which are warmth, softness to the hand, high extensibility, ability to felt and the ability to take up approximately one-third of its own weight in moisture without feeling wet (Moncrieff, 14).

Man-made staple yarns are generally made by cutting filament fibers the desired length and spinning them as natural fibers are spun into yarn. Man-made staple fibers spun by the woolen system assume the characteristics of wool (Hess, 11). However, they lose the properties of filament fiber yarns, which are strength, evenness, and resistance to pilling and shedding (Blore, 3). In order to retain the properties of filament fibers while assuming those of staple fibers, a new process known as texturizing, has been developed.

Textured yarns are "continuous filament yarns which have been modified so that the filaments do not lie parallel to each other" (Blore, 3). The purpose of making the filaments less parallel to each other is to create a yarn with characteristics of a spun yarn, namely absorbency, soft hand, opaqueness, warmth, and cover of wool.

Experiments were conducted in 1933 attempting to impart crimp to acetate yarns, but they were unsuccessful because the yarns were not suitable to such processes (Blore, 2). Textured yarns are now generally made of nylon or Dacron polyester but can also be made of nearly any man-made fiber. Orlon Cantrece is a new textured yarn introduced recently by Du Pont (Pratt, 15).

The real beginning of textured yarns was in 1947 when Helanca was introduced in Switzerland by Heberlein and Co., A.G., followed by Helanca's introduction in the United States during 1950 and 1951. Although textured yarns have long been used for novelty textured effects, this yarn, which made stretch socks possible, was not a passing fancy, but had commercial importance (21).

The increasing popularity of textured yarns is shown in their production figures. In 1956 twelve million pounds of nylon were modified into bulk and stretch yarns and by 1958 this figure had grown to 30 million pounds. It is conservatively estimated that by 1961, over 50 million pounds will be modified (1).

The reason for textured yarns' tremendous increase in production is the many advantages which they offer to the consumer. Textured yarns of nylon simulate the characteristics of hi-bulk spun yarns and have additional values, such as no pilling and absence of broken filaments. They combine high abrasion resistance, strength and the toughness of nylon with bulk, comfort, thermal insulation, and satisfactory absorption properties. They enable manufacturers to produce one-size items which fit several sizes of wearers. Their texture can vary from one of unusual

softness to one of firm crispness, depending upon the method and conditions of production. Fabrics made of textured nylon yarns are extremely durable, easy to wash and dry rapidly. They do not felt, can be made dimensionally stable, and feel warmer than regular nylon (22).

The three types of textured yarns are bulk yarns, stretch yarns, and modified stretch yarns. All are modified continuous filament yarns, but they vary as to the degree and method of modification and their desired end-use. Bulk yarns are continuous filament yarns which have been modified to give greatly increased mass or bulk per unit length. This bulk is permanent, whether the yarn is in a relaxed or extended condition. They can exhibit varying degrees of stretch, depending upon the method and conditions of texturizing. Trademarks of yarns of this type are Spunized, Textralized, and Taslan.

Stretch yarns are characterized by high elongation, rapid recovery, and permanent crimp retentivity. Helanca, Superloft, and Agilon are trademarks of yarns of this classification. Modified stretch yarns (Saaba, Helanca SS, and Helanca SW) are stretch yarns which have been modified under controlled conditions of tension, temperature, and heating time to remove some of their stretch and yet retain maximum bulk (21).

The three types of textured yarns are produced by a continuous operation at high speed. The individual, continuous filaments are displaced from their natural and relatively close-packed positions at the present time by four methods of mechanical

distortion which give them permanent bulk and/or stretch characteristics. This distortion is made permanent if heat is applied to thermoplastic fibers during the mechanical distortion or by an additional process (22).

One method of mechanical distortion is to force the thermoplastic yarns into a heated, V-shaped stuffing box, which produces crimped yarns, such as Textralized and Spunized. Another method is to run the yarn between two heated gears which are meshed together, producing a curled yarn, Agilon. Coiled yarns, as the Helancas and Superloft, are produced by a third method, which is the drawing of fibers over a heated, sharp blade. The fourth method is to blow the filaments across a jet of compressed air faster than they are taken away, making small loops in the yarn. Taslan is the trademark of the yarn made by this method (Blore, 3).

The introduction of man-made fibers in the last ten years is responsible, in part, for a 25 per cent increase in the output of knitted yard goods and apparel. This is especially true in the area of women's sweaters, which has increased 300 per cent (Press, 17).

Knitting is the interlooping of yarn in a series of connected loops, by means of needles, either by hand or by machine (Carmichael, 5). The two types of knitting are filling and warp. In filling knit, the loops run crosswise of the fabric and each links into the one on the preceding row. Hand knitting is done by this method, but warp knitting may be produced only by machine. In warp

knit the chain stitches are "tied together by the zigzag of the yarns from one needle to another." The resultant fabric will not drop stitches, is stronger, and of closer construction than that made by filling knit (Wingate, 24).

The important characteristics of filling knit fabrics are their stretch and elasticity, but others include their high order of wrinkle resistance, ease of care, good drapability, comfort, and being soft and light in weight (Press, 17). Filling knit goods are especially suitable for use in the production of sweaters because their characteristics of stretch and elasticity are desired in sweaters. Textured yarns were first experienced in filling knit goods because the characteristics of each were compatible.

Because sweaters are such an important part of the college woman's wardrobe their acceptability after periods of wear is of great importance. The purpose of this study was to compare the acceptability of sweaters knitted of textured yarns and those made of yarns of man-made staple fibers after laundering and after wear and laundering by subjective and objective evaluations.

## REVIEW OF LITERATURE

A review of literature on outer knit wear and the acceptability of textured yarns revealed that little information has been published on these subjects. However, available information on fibers and yarns, sweater construction, and selection of sweaters has bearing on the topic.

## Types of Fibers and Yarns

Orlon acrylic fiber was developed by the Du Pont Company during World War II and by early 1946 this new fiber looked promising enough for commercialization, and the process development continued. Commercial production of Orlon 81 continuous filament and Orlon 41 staple fiber began in 1950 (Mauersberger, 13). Orlon 42 replaced Orlon 41 in 1953 as the staple fiber being produced (Moncrieff, 14). According to the Federal Trade Commission's Trade Rules and Practices under the Textile Fiber Products Identification Act, Orlon acrylic is included in the generic classification of acrylics. The Federal Trade Commission defines an acrylic as "a manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 85 per cent by weight of any acrylonitrile units" (9). The physical properties of Orlon acrylic yarns include a warm hand, high bulking power, and recovery from wrinkling in both dry and wet states. The high bulking power gives high insulating power, high coverage, and increased yardage per pound to the yarns (Mauersberger, 13).

Orlon acrylic staple fiber is the leading man-made fiber used today in the knitted outerwear industry, as it accounts for from 45 to 50 per cent of the aggregate sweater volume. However, the demand for the fiber has diminished in the last two years, more so in the highly competitive ladies' and teen-age girls' branches than in other size and sex categories. In the men's and

boys' category it has increased about 50 per cent. Next in popularity is filament nylon in the form of modified or bulked yarns (Press, 17).

Tycora is the registered trademark used to identify the textured yarns produced by the Textured Yarn Company of Philadelphia, Pennsylvania (20). "Tycora symbolizes a source of manufacture and not the method of manufacture since the trademark Tycora is used to designate textured yarns produced under several techniques" (1). Nylon and Dacron polyester are used in the production of Tycora (Blore, 3) and other than this, little or no information has been released about Tycora.

In reference to Ban-lon two terms or trademarks are used: Textralized and Ban-lon. Textralized "identifies the yarn that has been modified by the exclusive crimping process of Joseph Bancroft and Sons, Co., of Wilmington, Delaware." Ban-lon "identifies the garments, fabrics and articles which are made wholly or principally from Textralized yarn providing the products meet the rather rigid quality control standards which have been set up by Bancroft" (23).

As yet, Ban-lon has been made of nylon or Dacron polyester continuous filament yarn, but the Bancroft Company has been experimenting with other fibers and will soon be ready to release them. Nylon has been the principal fiber used because of its many desirable characteristics, namely strength, elasticity, and toughness. When texturized, nylon has an extensibility of over 200 per cent and is still able to recover this stretch when released.

It will absorb moisture up to 13 times its weight because moisture is held mechanically in the interstices between the crimped fiber. It has good thermal insulation and resilience to abrasion and pilling (Monorieff, 14).

To produce Textralized yarns the continuous filament yarns are placed in a stuffer box heated to 420° F. for nylon 66 and somewhat lower for nylon 6. Inside the chamber of the stuffer box is a weighted tube of a considerably smaller diameter than the chamber. As the fiber is fed into the chamber it is folded against the tube, which slowly is pushed upward in the chamber. The weight of the tube, the heat in the chamber, and the length of time the yarn is held in the folded position determine the amount and permanence of the crimp in the yarn (Press, 16).

The Joseph Bancroft Company controls the quality of its product by demanding that the yarn spinners who desire to use the Textralized label first send sample cones to them for approval or improvement suggestions. Weavers, knitters, and manufacturers must do the same for any product on which they desire to use the Ban-lon label (23).

## Sweater Construction

Johnstone (12) has discussed the qualities which should be considered when selecting a sweater. A resumé of the qualities concerning the construction of sweaters follows.

Information necessary to judge the quality of the sweater include "knowledge about the different kinds of knitting, quality of materials, methods of construction, and grades of workmanship--

and what to expect from each in service and appearance" (12).

The manner in which the parts of a sweater are shaped and joined together is a guide to the quality of the sweater. They may be either full-fashioned or cut-and-sewn. Full-fashioning is achieved by knitting the different parts--sleeves, front and back--on "flat machines that shape and bind off the edges as they knit. This shaping is done by increasing or decreasing the number of stitches, which make little fashioning stitches" (12). Fashioning is most commonly located around the armscye, but is also found around the neckline and on both sides of the sleeve seam and underarm seam. Because fashioning is a sign of quality "stitches that look like fashioning marks, but are only for appearance are sometimes found in cut-and-sewn sweaters" (12). If the marks are genuine the rows of knit stitches come together at an angle; if mock-fashioned, the rows are parallel. Cut-and-sewn sweaters vary as to quality, but in order to be a high-grade sweater the parts must be accurately cut on the wales and courses so that the sweater will not sag or twist.

Since the shaped-as-knit pieces of full-fashioned sweaters will not ravel, their seams may be joined either by looping or overlocking. In a looped seam the pieces are machine stitched close to the edges to produce a fine, soft, flat seam that is elastic and comfortable. In an overlocked seam the two bound-off edges that are joined by a stitch, which looks like a buttonhole stitch, are not as flat or as flexible as a looped seam. The seams of cut-and-sewn sweaters must be stitched securely and

covered to keep the cut edges from raveling. This is done by using merrowed seams, stitching and covering the edges of the pieces of sweater simultaneously, or using such seam coverings as straight tape, a strip of knit fabric, or an overlock stitch.

Another area of workmanship to be examined is the neck finish. A neck finish may be either single-looped or double-looped. "A single-looped neckline has only one thickness of ribbing, bound off on the outer edge. Double-looped means that the ribbing is actually double, with a fold on the neck-edge. A double-looped neck has less stretch than a single-looped one, but keeps its shape better" (12). An elastic thread is sometimes run through the neckline fold to help hold its shape.

A good quality front opening follows one lengthwise rib of the sweater and is faced with grosgrain ribbon. A grosgrain ribbon facing makes a neat finish and is a strong reinforcement for buttons and buttonholes, but it may fade or shrink, and spoil the appearance of the sweater. Knit bandings may be used but they are more bulky. A well-made buttonhole is firmly reinforced, is cut straight both with the knit and reinforcement and the stitches are close together and deep enough to prevent pulling out and to cover the cut edges. Both the buttons and buttonholes should be evenly spaced.

## Pilling

Pilling is defined as the "formation of bunches or balls of tangled fibers on the surface of a fabric" (Press, 16). In order

for pilling to take place there must be available loose fiber ends at or near the surface of a fabric and mild frictional action during wear that combines both linear and rotational rubbing forces. Pilling is increased if short, fine fibers, resulting in an increased number of fiber ends per unit weight, and uneven yarns, containing the thicker, softer, less oriented portion of the yarn, are used. Pilling is decreased by increasing the twist of the yarn, which reduces the number of fiber ends, and by applying special finishes to the fabric (Press, 17).

Pilling has become increasingly important with the development of the staple yarns of man-made fibers. Fabrics made from these fibers, because of the static quality and the length of the fiber, become fuzzy, attract lint and become covered with pills to a greater extent than is apparent on fabrics made of natural fibers. Fabrics made of wool do not appear to pill as badly because wool fibers are weaker, generally more coarse, and tend to entangle and felt together.

In fabrics made of man-made fibers, pills are formed in two stages. The fabrics first become fuzzy as the surface fibers are roughed up. This fuzzing may take place over the entire garment before any pills form. Following this fuzzing, in areas where special conditions of wear exist, the raised fiber ends become entangled and pills are formed (Press, 16). The pills become larger as the continued friction pulls the attached fiber out of the fabric, and additional fiber ends are drawn into the pill. Continued abrasion will result in the wearing down and the eventual

destruction of the fabric.

According to Press (16) pills may be classified in two types: lint or fabric pills. Fabric pills consist of fibers from the fabric, while lint pills are formed when extraneous lint becomes trapped in the pill during formation.

With the increasing importance of pilling, the existing laboratory methods of measuring the amount of pilling were neither satisfactory nor suited to the type of evaluation which was needed. The Navy developed the Appearance Retention tester to meet this need. The results obtained from this laboratory method of pilling compare favorably with pilling from actual wear for both hard and soft fabrics (Press, 16).

## Satisfaction with Sweaters

Swanson (19) interviewed 70 undergraduate women to investigate the factors and their interrelationships causing satisfaction in sweaters. Satisfaction was rated according to such components as becomingness, ease of care, fulfillment of purpose, physical comfort, and psychological comfort. The factors most frequently mentioned as causing satisfaction in sweaters were: color, fit, style, and fiber or fabric, with price being relatively less important. A consumer should understand the operation of these factors and consider them when selecting a sweater in order to make a choice that is becoming to her and one in which she will feel at ease.

In a related study Finlayson (10) interviewed the same sample of undergraduate women as did Swanson to investigate the

relationship of general personal values and components of satisfaction, both of which are considered motivating factors in clothing selection. A rating of six components of satisfaction with sweaters, namely: becomingness, beauty, comfort, liked by friends, ease of care, and good buy, showed that becomingness was the most important component to most of the respondents. The most common reason given by the respondents for this rating was social approval, followed by aesthetic pleasure.

## METHOD OF PROCEDURE

The acceptability for wear of sweaters made of textured filament yarns and staple yarns of man-made fibers was determined by objective and subjective methods. Whether it is the laundering or the wear and laundering which affect a sweater's acceptability was also measured.

### Selection and Treatment of Sweaters

Cardigan sweaters constructed by filling knit and made of Tycora and Banlon textured nylon yarns and Orlon acrylic staple yarns were purchased on the open market. The sweaters were full-fashioned with set-in, long sleeves and a double-looped neckline. Two lots of each type were selected, the lots being designated by different colors, tan and light blue. Four sweaters of each lot and type were purchased, making a total of 24 sweaters.

The sweaters were divided into four sets, each set being composed of one sweater of each type and lot. One set was used as

purchased in the analysis of the fabric. A second set, not worn and not laundered, was used as a standard for the subjective evaluation. A third set was not worn, but laundered, in order to determine the effect of laundering on a sweater's acceptability for wear. The fourth set was worn and laundered to determine the effect of laundering and wearing on a sweater's acceptability for wear.

## In-service Procedure

Three women were chosen to wear the sweaters to be worn and laundered. They wore the sweaters of one color lot and type for at least nine or ten hours per day for five days and then returned them to the laboratory for laundering and evaluation. The periods of wear were from Wednesday through Friday, and the following Monday and Tuesday, thus allowing the women to have some variety in their wardrobes. The schedule was devised so that the sweaters were rotated among the women, no sweater being worn more than twice by the same wearer. The three women alternately wore tan and light blue sweaters for ten weeks.

The five weeks, or 25 days, of wear and five washings were assumed to simulate at least a year's wear by the average college woman.

The women were given the following instructions on the wear and care of the sweaters: they were to conduct their usual activities and in no way attempt to save or protect the sweater, thus subjecting the sweater to the usual wear resulting from the

activities common to college women; they were to wear dress shields or a blouse under the sweater at all times; and when not being worn the sweater was to be folded lengthwise and placed over a chair back or on a crossbar of a hanger.

## Laundering Procedure

The sweaters which were to be worn and laundered and the ones to be laundered only were submitted to the same laundering procedure. The sweaters which had been worn were washed together and those which had not been worn, washed together.

Upon the recommendation of the handbook for the operation of the washing machine the sweaters were turned wrong side out, left unbuttoned, and placed in individual white cotton knit bags and washed with three bath-size white terry towels. These precautions were taken to protect the sweaters from the breaking and spinning action of the washing machine.

The sweaters were washed in a tumbler type automatic washer for five minutes and then allowed to continue the rinsing and spinning cycle of the machine, which was: to drain and spray (four minutes), to refill, rinse and drain twice (ten minutes), and spin and drain (four minutes). City water with 65 ppm hardness at $100 \pm 5^{\circ}$ F. and 35 grams of neutral soap, Federal Specifications P.S. 566b, were used.

A tumbler-type automatic drier set at "No Heat" was used for drying the sweaters. Again following the recommendations of the handbook, the sweaters, still in the bags, and three dry white

bath-size terry towels were placed in the drier for 40 minutes. Because the sweaters were not completely dry at the end of this period, they were removed from the bags and placed on a flat surface covered with white, terry towels and allowed to dry overnight. Care was taken not to distort the sweaters in any way, allowing them to dry in their natural positions.

After the sweaters were dry they were steamed on the wrong side to remove wrinkles. In order not to distort the yarns the steam iron was held one-half inch above the sweater and the steam allowed to penetrate in each position for approximately five seconds.

## Analysis of Fabric

The fabric of the sweater, as purchased, was analyzed as to type of knit and density, according to Federal Specifications Method 5070 (8). The construction of the sweaters was also analyzed as to the types of stitches and stitching, according to Federal Specifications DDD-S-751 (7). The location and number of fashioning marks, neck finishes, front openings, and width of bandings were noted.

Pilling was determined by using two laboratory instruments, the Appearance Retention tester and the Schiefer abrader. The locations on the sweaters from which the specimens were obtained are shown in Plate I. Pilling was determined on the prescribed number of specimens by using the Appearance Retention tester and the procedure according to Designation 1375-55T (D) of the American

## EXPLANATION OF PLATE I

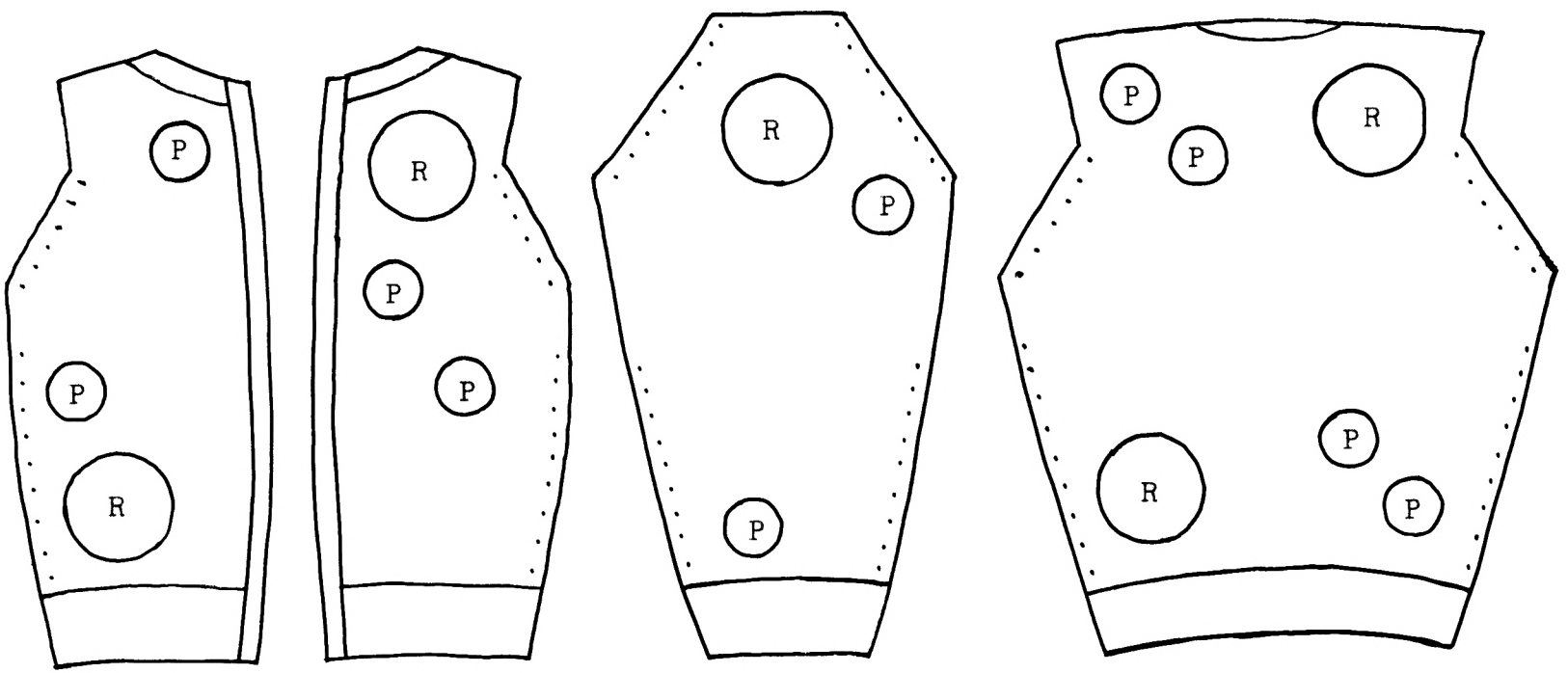
Locations of the Specimens for Pilling

Key:

R - Specimens tested by the Schiefer abrader

P - Specimens tested by the Appearance Retention tester

PLATE I



Society of Testing Material's Committee D-13 (6). The specimens were tested for 15 seconds (21 cycles ± 2 cycles) and evaluated as to the amount of pilling by using the Standards for Visual and Comparative Evaluation of Degree of Pilling developed by the Fabric Development Tests. During the preliminary investigation the Tycora and Ban-lon specimens tended to stretch and cling to the rough surface of the pilling disk as it revolved, instead of remaining tightly against the specimen holder. To prevent this the specimens were stretched an equal amount as they were mounted onto the specimen holder.

Pilling was also determined by using the Schiefer abrader and the attachments specified by the Federal Specifications CCT-191b (8) for woven fabrics. The attachments for knitted fabrics were used during the preliminary investigations, but it was found that the Tycora and Ban-lon specimens repeatedly pulled out of the lightweight clamp. To correct this difficulty the attachments for woven fabrics were used and the specimens were evenly stretched and then taped to the inside of the clamp. The specimens were tested for 22 cycles ± 1 cycle with three pounds of weight in order that the results of the Appearance Retention tester and the Schiefer abrader would be comparable. The amount of pilling was measured on a four-point rating scale ranging from "No Fuzz" to "Excessive Fuzz" in order that the results be comparable to those evaluated by the Standards for Visual and Comparative Evaluation of Degree of Pilling.

The sweaters which were worn and laundered and those only laundered were measured as purchased and following each laundering and pressing for dimensional stability. The positions of the measurements, as shown in Plate II, were determined by the Commercial Standard CS215-58 of the United States Department of Commerce, Office of Technical Services (4). The percentage change which the sweaters underwent after five launderings was determined and the variations between the sweaters of different treatments analyzed.

Color change was determined by the Bausch and Lomb Spectronic Colorimeter 20 with Reflectance Attachment. Ten readings were taken in the positions of the specimens designated for pilling with the Schiefer abrader as shown in Plate I, except that the locations on the lower part of the sleeve were not used. After the last treatment, readings were taken in the same positions of the sweaters which had been worn and laundered and those not worn, but laundered. Using the B and L Trichromatic Coefficient Computing Form for Illuminant C, the amount of color change of each sweater was determined. The statistical significance of the color change was determined by the Chi-square statistic at the rejection level of five per cent (18).

## Methods of Evaluation

Subjective Evaluation. A panel, composed of five impartial college women and instructors, evaluated the sweaters against the standard after each treatment for the amount of pilling, amount of

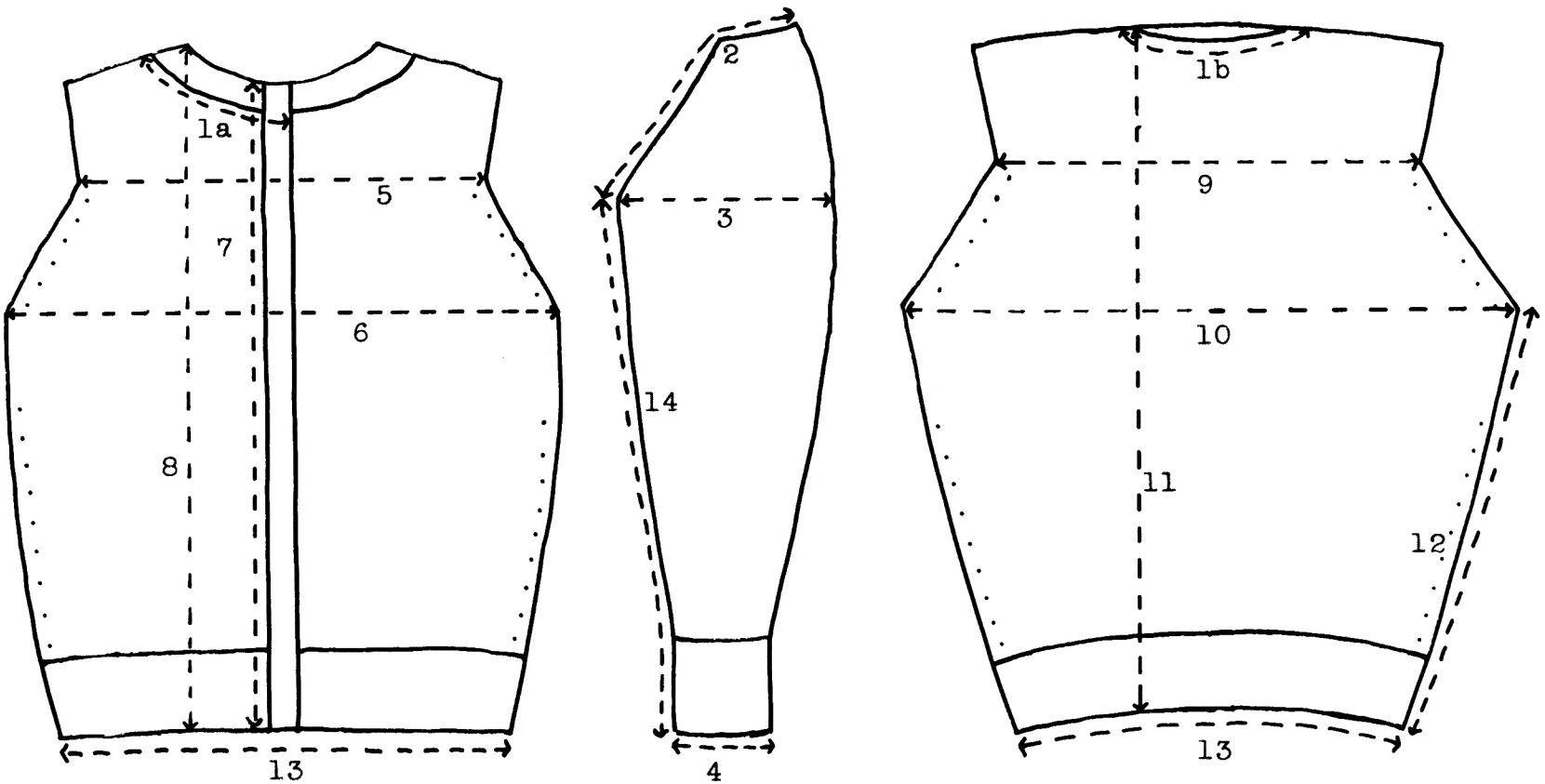
## EXPLANATION OF PLATE II

### Locations of the Measurements for Dimensional Stability

Key:

1a - Front neckline, from shoulder seam to front opening
1b - Back neckline, from shoulder seam to shoulder seam
2 - Armscye
3 - Upper sleeve, one-half width
4 - Sleeve cuff at lower edge, one-half width
5 - Front upper chest, from armscye to armscye and three inches below the shoulder seam
6 - Front chest, from side seam to side seam and one inch below armscye
7 - Front opening, along grosgrain ribbon from neckline to lower edge
8 - Front lengthwise, from shoulder seam to lower edge of body ribbing
9 - Back upper chest, from armscye to armscye and two and one-half inches below the shoulder seam
10 - Back chest, from side seam to side seam and one inch below armscye
11 - Back lengthwise, from shoulder seam to lower edge body ribbing
12 - Underarm seam, from armscye to lower edge of body ribbing
13 - Lower edge of body ribbing, entire width
14 - Sleeve seam, from armscye to lower edge of cuff ribbing

PLATE II



snagging and overall appearance. Each sweater was evaluated individually under a daylight lamp, using the not worn and not laundered sweater of the same lot and type of yarn as the sweaters being judged for the standard. The panel members did not know the treatments given the sweaters nor the type of sweaters which they were examining. Each member was instructed to use her own judgment and personal taste for sweater acceptability when determining her answers. They were given as much time as they needed to examine the sweaters and to mark their answers.

The form of the evaluation sheet used is shown in the Appendix. Snagging and overall appearance were evaluated on a five-point rating scale, ranging from "No Snags" and "Little or No Change" to "Over 12 Snags" and "Excessive Change." These evaluations were assigned a numerical score, with "Little or No Change" and "No Snags" given the number five, and "Excessive Change" and "Over 12 Snags," the number one. The numerical scores were then ranked with the highest score being assigned the rank of number one. The decisions as to the amount of pilling were based upon the Standards for Visual and Comparative Evaluation of Degree of Pilling, which were developed by the Fabric Development Tests (6). These decisions were also given a numerical score, four being assigned to the category "No Pills" and one, to the category "High Pills." These scores were then ranked as were those for snagging and overall appearance.

Objective Evaluation. The objective evaluations were: the laboratory evaluations of pilling of the sweaters, as purchased,

by the Schiefer abrader and the Appearance Retention tester; the measurements taken to determine dimensional stability of the not worn, but laundered, sweaters and the worn and laundered sweaters; and the readings taken to determine the amount of color change before and after wearing and laundering. The procedures used in these objective evaluations were described in the Analysis of Fabric.

## DISCUSSION AND FINDINGS

The body of the sweaters was filling knit with a plain stitch, while the ribbings were of a one-by-one rib stitch. The Tycora sweaters were the most closely knit, having 19.4 courses and 28.4 wales per inch. The wales of the Orlon acrylic and Ban-lon sweaters were nearly the same, with the Ban-lon sweater having 23.9 wales per inch and the Orlon acrylic sweater, 24.0 wales per inch. However, the Ban-lon sweater had 18.0 courses per inch and the Orlon acrylic sweater, 16.3 courses per inch.

All of the parts of the sweaters were shaped-as-knit, allowing the seams to be soft and flat. The armscye seam was of two types of construction. In the area five inches on either side of the shoulder seam the sleeve and body of the sweater were joined by looping, which is the hand process which continues the knitting without a seam (Johnstone, 12). The remainder of the armscye was Seam Type SSa-1 and sewed with Stitch 101. The stitching started at the underarm seam and continued to the looping on the front and back of the armscye seam.

The seams of the body of the sweater were also Type SSa-1 and sewed with Stitch 101. The size of stitch used on the seams varied from 15 stitches per inch of the Tycora sweater to 9 stitches per inch of the Orlon acrylic sweater. The underarm and sleeve seams of the Ban-lon and Tycora sweaters were continuous. The stitching of the seams for both sweaters started at the lower edge of the underarm seam and continued to the lower edge of the cuff of the Ban-lon sweater, but only to the top edge of the cuff of the Tycora sweater. The sleeve and underarm seams of the Orlon acrylic sweaters were not continuous. The stitching of each started at the top of the cuff ribbing and the ribbing at the lower edge of the sweater, respectively, and continued to the armscye, at which point there was an additional reinforcement with two rows of stitching. The ribbings at the lower edge of the sweater and cuff of the Orlon acrylic sweater and the cuff of the Tycora sweater were joined with Stitch 501 so that the edges just met, thus permitting the cuff of the sweater to be turned back without the seam showing. All the sweaters were reinforced at the end of the seams, but the Orlon acrylic sweater had the most secure reinforcement because the ends of the thread were worked back into the line of stitching (Table 1).

The Orlon acrylic and Tycora sweaters contained fashion marks in four areas: the neckline, armscye, sleeve seam, and underarm seam; while the Ban-lon sweater had marks only at the neckline and the armscye.

The neckline of each sweater was double-looped and sewed with Stitch 101 and self thread. A single elastic thread was

Table 1. Analysis of sweaters.

| | :Orlon* acrylic: | Ban-lon* | : Tycora* |
|---|---|---|---|
| Type of knit | | | |
| Body | plain | plain | plain |
| Ribbing | one-by-one rib | one-by-one rib | one-by-one rib |
| Density of fabric | | | |
| Courses per inch | 16.3 | 18.0 | 19.4 |
| Wales per inch | 24.0 | 23.9 | 28.4 |
| Seam construction | | | |
| Body | | | |
| Type of seam | SSa-1** | SSa-1 | SSa-1** |
| Type of stitch | 101 | 101 | 101 |
| Stitches per inch | 9 | 11 | 15 |
| Neckline | | | |
| Type of seam | double-looped | double-looped | double-looped |
| Type of stitch | 101 | 101 | 101 |
| Stitches per inch | 23 | 25.5 | 22.5 |
| Front edge | | | |
| Type of seam | LSa-2 | LSa-1 | LSa-2 |
| Type of stitch | 401 | 301 | 402 |
| Stitches per inch | 10 | 14.5 | 10.5 |
| Fashion marks | | | |
| Number | | | |
| Underarm | 16 | 0 | 11 |
| Sleeve | 19 | 0 | 33 |
| Armscye | 26 | 24 | 25 |
| Neckline | 8 | 7 | 10 |
| Front opening | | | |
| Facing | grosgrain ribbon | grosgrain ribbon | grosgrain ribbon |
| Buttonholes and buttons | 10 | 9 | 10 |

* Registered trade names.

** Ribbings at the bottom of the edge of the sweaters and on the cuff of the Orlon acrylic and the cuff of the Tycora sweaters were joined with Stitch 501 so that the edges just met.

attached to the inside fold of the neckline of the Orlon acrylic sweater to prevent stretching.

Matching grosgrain ribbon was used as the facing of the front openings of the sweaters. The Tycora and Orlon acrylic sweaters had ten, evenly spaced pearl buttons and buttonholes, while the Ban-lon sweater had nine. The buttonholes were vertical except for the top one of the Orlon acrylic and Ban-lon sweaters, which was horizontal. The grosgrain ribbon was not stitched exactly parallel with the knit on any of the sweaters (Table 1).

## Objective Evaluation

Pilling. To determine the amount of pilling, the specimens were tested by two machines, the Appearance Retention tester and the Schiefer abrader, and then evaluated according to the Standards of Visual and Comparative Evaluation of Degree of Pilling. When tested by the Appearance Retention tester the Orlon acrylic specimens had the most pills, with a rating of 1.2. The Ban-lon specimens, with a rating of 3.3, or a low number of pills, had the least number of pills. The ratings of the blue and tan Tycora specimens varied one numerical score, the tan having a rating of 3.2 and the blue, a rating of 2.2, which averaged 2.7, or between a medium and low number of pills (Table 2).

The results of the testing by the Schiefer abrader showed that the blue and tan Tycora specimens were very resistant to pilling with an average rating of 3.9. The Orlon acrylic specimens were the least resistant to pilling with an average rating of 1.3, or

Table 2. Amount of pilling measured by two instruments.

| Instruments | Orlon* acrylic: Tan | Blue | Avg. | Ban-lon* Tan | Blue | Avg. | Tycora* Tan | Blue | Avg. |
|---|---|---|---|---|---|---|---|---|---|
| Appearance retention | | | | | | | | | |
| Rate | 1.2 | 1.2 | 1.2 | 3.2 | 3.4 | 3.3 | 3.2 | 2.2 | 2.7 |
| Rank | | | 3 | | | 1 | | | 2 |
| Schiefer abrader | | | | | | | | | |
| Rate | 1.2 | 1.4 | 1.3 | 3.8 | 3.6 | 3.7 | 3.8 | 4.0 | 3.9 |
| Rank | | | 3 | | | 2 | | | 1 |

* Registered trade names.

"High" degree of pilling. The fuzz raised up on the surface of the Ban-lon and Tycora specimens was slight, and although there was extensive fuzz on the surface of the Orlon acrylic specimens, no pills were formed on any of the specimens.

When comparing the results of the two methods of evaluating pilling, the Orlon acrylic sweaters ranked third in the evaluations of the specimens. The Ban-lon specimens ranked first among the specimens tested by the Appearance Retention tester and the Tycora specimens ranked first among the specimens tested by the Schiefer abrader. There was no significant difference at the five per cent rejection level between the Orlon acrylic and Ban-lon specimens tested by the two instruments, indicating agreement between the instruments, while there was variation between the results of the Tycora specimens.

Change in Color. All the sweaters which were not worn but laundered and those worn and laundered underwent a change in color as determined by the B and L Trichromatic Coefficient Computing

Form for Illuminant C. Only the blue Orlon acrylic sweater which was not worn but laundered showed a significant amount of change at the five per cent rejection level, as determined by using the Chi-square statistic. Table 3 shows the numerical value of the color of each of the sweaters.

Table 3. Numerical value of the color of sweaters.

| Treatment of sweaters | Orlon* acrylic | | | | Ban-lon* | | | | Tycora* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | blue | | tan | | blue | | tan | | blue | |
| | X | Y | X | Y | X | Y | X | Y | X | Y |
| As purchased | .279 | .289 | .326 | .341 | .282 | .300 | .325 | .331 | .286 | .299 |
| Not worn, but laundered | .267 | .278 | .335 | .342 | .271 | .296 | .333 | .335 | .284 | .298 |
| Worn and laundered | .271 | .280 | .335 | .344 | .279 | .295 | .335 | .337 | .287 | .300 |

* Registered trade names.

Dimensional Stability. The dimensional change of the sweaters of the same type of yarn, but of different lots, and which had the same treatment, that is, not worn but laundered and worn and laundered, varied as to their per cent of dimensional change after five launderings. The greatest variation was at the lower edge of the ribbing of the tan and blue Orlon acrylic sweaters, which had been worn and laundered; the tan lot showing 13 per cent shrinkage and the blue lot showing 13 per cent stretch, a variation of 26 per cent. Another variation was the 14 to 18 per cent shrinkage at the front upper chest measurement that the tan sweaters of all types of yarns which had been worn and laundered underwent, while

the blue sweaters of the same treatment were not similarly affected.

However, there were some noteworthy agreements in the percentage of dimensional change. The back neckline of all the sweaters, except the not worn but laundered Ban-lon sweaters, stretched from 2 to 11 per cent. The sleeve of the Orlon acrylic sweaters shrank from 8 to 15 per cent, while the back upper chest stretched from 2 to 13 per cent. The front opening, along the grosgrain ribbon, on all the sweaters had little dimensional change, the largest amount was the three per cent shrinkage of blue, worn and laundered Tycora sweater.

The Orlon acrylic sweaters which were not worn but laundered, stretched both crosswise and lengthwise more than they shrank. Both the upper back chest and back chest measurements of the Orlon acrylic sweaters, whether only laundered or worn and laundered, stretched. Locations which stretched in the Orlon acrylic sweaters measured were the back neckline, front lengthwise, back upper chest, back chest, and sleeve seam (Table 4).

Wearing had the greatest effect on the dimensional change of the Ban-lon sweaters, as the percentage of change of the worn and laundered sweaters increased over that of the not worn but laundered sweaters in 11 measurements. Lengthwise, the Ban-lon sweaters had little dimensional change.

The Tycora sweaters also showed little lengthwise change. However, crosswise, the Tycora sweaters showed variations, with the tan worn and laundered sweater showing shrinkage of 11 per

Table 4. Per cent of dimensional change after five launderings.*

| Areas of measurement | Orlon** acrylic: tan | Orlon** acrylic: blue | Ban-lon**: tan | Ban-lon**: blue | Tycora**: tan | Tycora**: blue |
|---|---|---|---|---|---|---|
| **Not worn but laundered sweaters** | | | | | | |
| 1a. Front neckline | -3 | 4 | 0 | 0 | 2 | 0 |
| 1b. Back neckline | 5 | 8 | 0 | 2 | 3 | 8 |
| 2. Armscye | 0 | 3 | 0 | 4 | 3 | 2 |
| 3. Sleeve, width | -10 | -14 | 1 | 0 | 0 | 1 |
| 4. Cuff, width at bottom edge | 3 | 2 | 0 | -3 | 0 | 3 |
| 5. Front upper chest | 5 | -3 | -5 | -1 | 0 | 2 |
| 6. Front chest | 1 | 0 | 2 | 0 | -1 | 3 |
| 7. Front opening | 2 | 0 | 1 | -1 | -1 | -3 |
| 8. Front lengthwise | 4 | 2 | 1 | 3 | -3 | 1 |
| 9. Back upper chest | 12 | 5 | -3 | 2 | 0 | 3 |
| 10. Back chest | 8 | 13 | -8 | 3 | 3 | 3 |
| 11. Back lengthwise | -6 | -1 | 0 | 1 | 1 | 2 |
| 12. Underarm seam | 4 | -5 | -4 | 2 | 2 | 2 |
| 13. Bottom edge,width | 2 | 9 | 3 | 5 | 5 | 6 |
| 14. Sleeve seam | 6 | 2 | -2 | 1 | -1 | 0 |
| **Worn and laundered sweaters** | | | | | | |
| 1a. Front neckline | 11 | 2 | 0 | 7 | 2 | 0 |
| 1b. Back neckline | 4 | 7 | 4 | 6 | 5 | 8 |
| 2. Armscye | -4 | 0 | 0 | 4 | -11 | 2 |
| 3. Sleeve, width | -8 | -15 | 3 | 5 | 1 | 1 |
| 4. Cuff, width at bottom edge | -3 | 8 | 0 | -6 | 0 | 3 |
| 5. Front upper chest | -15 | 0 | -14 | 0 | -18 | 2 |
| 6. Front chest | -5 | -1 | -3 | 0 | -2 | 3 |
| 7. Front opening | 0 | 1 | 0 | 0 | 0 | -3 |
| 8. Front lengthwise | 3 | 6 | 2 | 3 | 1 | 1 |
| 9. Back upper chest | 3 | 8 | 11 | 1 | 0 | 3 |
| 10. Back chest | 2 | 5 | 4 | 6 | 2 | 3 |
| 11. Back lengthwise | -2 | 0 | -1 | 3 | 1 | 2 |
| 12. Underarm seam | 0 | -3 | 1 | -2 | 0 | 2 |
| 13. Bottom edge,width | -13 | 13 | -1 | 10 | 0 | 6 |
| 14. Sleeve seam | 5 | 1 | -1 | 0 | 2 | 0 |

* A minus sign means the change was shrinkage; no sign indicates stretch.

** Registered trade names.

cent at the armscye and 18 per cent shrinkage at the front upper chest measurement. Table 4 gives the per cent change in all the areas of measurement of the sweaters after five launderings.

## Subjective Evaluation

An impartial panel evaluated the sweaters after laundering for the amount of pilling and snagging and their overall appearance.

Pilling. The evaluations of the panel showed that the amount of pilling of the Ban-lon and Tycora sweaters was little affected by the laundering treatment, both rating very close to the category of "No Pills." Of the sweaters not worn but laundered the Orlon acrylic sweater had the largest number of pills, with a rating of 3.5, or from between three to nine pills. Of the sweaters worn and laundered the Tycora sweaters, with a rating of 3.6, had the least number of pills, while the Orlon acrylic, with a rating of 2.6, which is from 10 to 20 pills, had the most pills (Table 5).

The number of pills increased on the sweaters of all types of yarns which had been worn and laundered over those laundered but not worn. Tycora had the smallest increase in the number of pills with an eight per cent increase, while the Orlon acrylic sweaters had the largest increase, with a 29 per cent increase.

According to the evaluations by the panel, little pilling occurred on any of the sweaters, including the worn and laundered Orlon acrylic sweater. Its rating of 2.6, was not in the "Low

Table 5. Results of the subjective evaluation.

| Treatment of sweaters | Pilling | | Snagging | | Overall appearance | |
|---|---|---|---|---|---|---|
| | Rate | Rank | Rate | Rank | Rate | Rank |
| Orlon* acrylic | | | | | | |
| Worn and laundered | 2.6 | 3 | 4.8 | 1 | 2.5 | 3 |
| Not worn, but laundered | 3.5 | 3 | 4.9 | 3 | 4.0 | 3 |
| Per cent difference between treatments | 29.0 | 3 | 0.4 | 1 | 38.0 | 3 |
| Ban-lon* | | | | | | |
| Worn and laundered | 3.3 | 2 | 4.6 | 3 | 3.9 | 2 |
| Not worn, but laundered | 3.9 | 1.5 | 4.9 | 2 | 4.3 | 2 |
| Per cent difference between treatments | 17.0 | 2 | 5.0 | 3 | 8.0 | 1 |
| Tycora* | | | | | | |
| Worn and laundered | 3.6 | 1 | 4.7 | 2 | 4.2 | 1 |
| Not worn, but laundered | 3.9 | 1.5 | 4.9 | 1 | 4.7 | 1 |
| Per cent difference between treatments | 8.0 | 1 | 4.0 | 1 | 11.0 | 2 |

* Registered trade names.

Pilling" rating. The four possible ratings ranged from "No Pills," which had a rating of four, to "High Pilling," with a rating of one.

Snagging. Very few snags occurred on any of the sweaters as they averaged no higher than the second rating of "0-4 Snags," although the highest rating was "Over 12 Snags." There was no significant difference between the sweaters which had not been worn, but laundered, as to the amount of snagging. Wearing had no

effect on the Orlon acrylic sweaters as the difference between the not worn but laundered sweaters and the worn and laundered sweaters was not significant at the five per cent rejection level, using the Chi-square statistic (Table 5).

Overall Appearance. When the panel evaluated the sweaters for overall appearance they considered such factors as the color change, dimensional stability, number of wrinkles, and amount of fuzz, in addition to the amount of pilling and snagging. The Tycora sweater had the best rating for overall appearance of the not worn but laundered sweaters, with a rating of 4.7, or slight change. Ban-lon was second with a rating of 4.3, and the Orlon acrylic sweater, third, or last, with a rating of 4.0. The Tycora sweater also had the best rating for the worn and laundered sweaters with a rating of 4.2. With the rating of 3.9 the Ban-lon sweaters were second and the Orlon acrylic sweaters were third with 2.5, which is "Considerable Change, but still Wearable."

The overall appearance of the Ban-lon sweaters was least affected by wearing, as the per cent decrease in ratings from the not worn but laundered to the worn and laundered sweaters was eight per cent. The Orlon acrylic sweater was affected the greatest amount by wearing, as it decreased 38 per cent.

## Acceptability of Sweaters

The subjective and objective methods of evaluation used in determining the sweaters' acceptability for wear after laundering

and after wear and laundering were in general agreement. By objective methods only the blue Orlon acrylic sweater which had not been worn, but laundered, showed a significant amount of color change. During the subjective evaluations the panel members commented occasionally on the apparent change in color of some of the sweaters from that of the standard. However, the sweaters were never judged unacceptable because of change in color. Therefore, the subjective and objective evaluations of change in color were in agreement.

The objective evaluations of dimensional stability showed variation among the locations and amounts of shrinkage and stretch of the different lots and types of sweaters. During their evaluation the panel members commented upon this inconsistency, but they never judged a sweater unacceptable for wear because of this change in dimensional stability.

When comparing the results of the subjective and objective evaluations of pilling, the Tycora sweaters ranked first, having the least number of pills by all procedures, except when tested by the Appearance Retention tester. By all procedures the Orlon acrylic sweater was ranked as having the greatest number of pills. There was the most agreement among the evaluations of the Ban-lon sweaters and the least agreement between the evaluations of the Orlon acrylic sweaters.

# SUMMARY AND CONCLUSIONS

Textured yarns, which are a recent development of the textile industry, are continuous filament yarns which have been modified so that they no longer lie parallel to each other in order that they might have the characteristics of a spun yarn, while retaining those of a filament yarn. Since little has been published on the acceptability for wear of sweaters knit of these yarns, the acceptability for wear of sweaters knit of Tycora textured yarns and Ban-lon textured yarns was compared with sweaters knit of Orlon acrylic staple yarns after laundering, and after wear and laundering. Orlon acrylic staple yarns were used as the comparison because they are the leading man-made fiber used today in the knitted outerwear industry. Sweaters made of Tycora and Ban-lon textured yarns were chosen because of their availability on the open market.

The sweaters' acceptability for wear after laundering and after wear and laundering was determined by subjective and objective methods. After being worn for five days the sweaters were laundered and pressed and then evaluated by an impartial panel. A sweater of the same lot and yarn as those worn was laundered, but not worn, and evaluated in order to determine if it is the laundering or the wearing which affect a sweater's acceptability for wear.

Results of the objective and subjective evaluation indicated that the Orlon acrylic sweaters had the least resistance to pilling. The Tycora and Ban-lon sweaters were resistant to pilling

by the subjective evaluation and by the objective method of determining the amount of pilling by the Schiefer abrader. They had more pills, as determined by the Appearance Retention tester, but still had only about half as many pills as did the Orlon acrylic sweater.

Although the sweaters had very few snags the Orlon acrylic sweater had the least number as a result of wearing and laundering. The Ban-lon and Tycora sweaters had few snags and were again closely related.

The Tycora sweaters had the best overall appearance with the Ban-lon sweaters next and Orlon acrylic sweaters last. The grosgrain ribbon of the Ban-lon sweaters which had not been worn but laundered shrank during the first laundering, giving the front edge of the sweater a puckered appearance, which lowered its rating.

All the sweaters underwent a color change, but only the change in color of the blue Orlon acrylic sweater which had not been worn but laundered was significant at the five per cent rejection level.

Both laundering and wear and laundering affected the dimensional stability of the sweaters, but laundering had the greater effect. Laundering had less effect on the Ban-lon and Tycora sweaters than it did on the Orlon acrylic sweaters, but the Ban-lon sweaters were more affected by wear than were the Tycora and Orlon acrylic sweaters. Both lengthwise and crosswise, all of the sweaters stretched more than they shrank. The sweaters were more

dimensionally stable lengthwise than crosswise, particularly those sweaters made of textured yarns. The smaller per cents of dimensional change might have been eliminated had the sweaters been blocked according to their original size before drying and allowed to dry in that position. Since the sweaters were rotated among the women wearing them the possibility that these changes were a result of the wear given them by a particular individual may be discarded. It is assumed that the differences in percentage of change were characteristic of the type of yarn of the sweater.

During the subjective evaluation no sweater was judged unacceptable for wear, although the Orlon acrylic sweaters had a high degree of pilling as evaluated by objective methods. The Tycora and Ban-lon sweaters were superior to the Orlon acrylic sweaters in the degree of pilling, dimensional stability, amount of change in color, and their overall appearance. However, the Orlon acrylic sweaters did not snag as badly during wear as did the Tycora and Ban-lon sweaters. From these results it may be assumed that all the sweaters were still acceptable after periods of wear, but that the Tycora and Ban-lon textured yarns were more acceptable than sweaters knit of Orlon acrylic staple yarns. It may also be assumed that wearing had a greater effect on the degree of pilling and snagging and the overall appearance of the sweaters, while it was the laundering which affected the sweaters' dimensional stability and caused a change in color.

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# APPENDIX

Form Used in the Subjective Evaluation

of the Sweaters

Cleaning # _____

# VISUAL EVALUATION OF SWEATERS

Name _____

Date _____

Evaluate the sweaters according to the number of snags and pills and their overall appearance in comparison with the standard. Check in one of the columns below the term which best suits your evaluation.

## SNAGGING

| | NO SNAGS | | | | | | Less than 4 Snags | | | | | | Between 4-8 Snags | | | | | | Between 8-12 Snags | | | | | | Over 12 Snags | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sweaters | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 |
| Sleeve | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Front | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Back | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

## PILLING

| | None (0-2) | | | | | | Low (3-9 Pills) | | | | | | Moderate (10-12 Pills) | | | | | | High (20 or more Pills) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sweaters | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 |
| Sleeve | | | | | | | | | | | | | | | | | | | | | | | | |
| Front | | | | | | | | | | | | | | | | | | | | | | | | |
| Back | | | | | | | | | | | | | | | | | | | | | | | | |

## OVERALL APPEARANCE

| | Little or no change Like New | Some Change but Highly Acceptable | Moderate Change but Acceptable | Considerable Change but Wearable | Excessive Change Unacceptable |
|---|---|---|---|---|---|
| Sweater #1 | | | | | |
| #2 | | | | | |
| #3 | | | | | |
| #4 | | | | | |
| #5 | | | | | |
| #6 | | | | | |

If you checked the sweaters unacceptable for wear, why? _____

# COMPARISON OF THE ACCEPTABILITY OF SELECTED SWEATERS MADE OF MAN-MADE FIBERS FROM DIFFERENT TYPES OF YARNS

by

JANE ANN DUNHAM

B. S., University of Kansas, 1957

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AN ABSTRACT OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Clothing and Textiles

KANSAS STATE UNIVERSITY
OF AGRICULTURE AND APPLIED SCIENCE

1960

Sweaters made of wool yarns dominated the sweater industry until about ten years ago when man-made fibers came into use. Staple yarns of these man-made fibers have been used in the production of sweaters because of the similarity of their characteristics with those of wool. These yarns are now being replaced, to some extent, by textured yarns which have the characteristics of staple yarns, but are made from filament fibers. The purpose of this study was to compare the acceptability of sweaters knit of textured yarns with those knit of man-made staple yarns after laundering and after wear and laundering.

Sweaters of Ban-lon and Tycora textured yarns and Orlon acrylic staple yarns were selected from two lots. A sweater of each lot and type of yarn was worn nine to ten hours a day for five days by three college women and then returned to the laboratory for laundering. An impartial panel evaluated the sweaters and ones of the same lot and type of yarn which had not been worn but laundered for the amount of pilling, snagging, and overall appearance by comparison with a sweater, neither worn nor laundered, of the same lot and type of yarn. The dimensional stability, amount of color change and pilling were determined by laboratory measurements. Pilling was measured by two instruments, the Appearance Retention tester and the Schiefer abrader.

The evaluation by the panel indicated that the Tycora sweaters maintained the best overall appearance, the Ban-lon sweaters the next best, and the Orlon acrylic sweaters, third after laundering and after wear and laundering. The sweaters showed little

snagging, but the Orlon acrylic sweaters were rated as having the least number of snags as a result of wear and laundering. The Orlon acrylic sweaters were rated as having the largest number of pills after laundering and after wear and laundering, while the Tycora sweaters were the most resistant to pilling. The panel did not judge any of the sweaters as unacceptable for wear because of a color change.

By laboratory measurements the Orlon acrylic sweaters were the least resistant to pilling. The Tycora sweaters were more resistant to pilling by the Schiefer abrader and the Ban-lon, more resistant by the Appearance Retention tester. However, by both instruments the Tycora and Ban-lon sweaters had only about half as many pills as did the Orlon acrylic sweaters. Laboratory measurements showed that the sweaters which had not been worn but laundered and worn and laundered underwent a color change, but only the Orlon acrylic sweater which had been not worn but laundered had a significant amount of change at the five per cent level of rejection.

Laundering and wear and laundering affected the dimensional stability of the sweaters. The Ban-lon and Tycora sweaters showed less dimensional change than did the Orlon acrylic sweaters, but the Ban-lon sweaters which had been worn and laundered showed more change than the Tycora and Orlon acrylic sweaters. The sweaters appeared to stretch more than they shrank and to have more crosswise change than lengthwise change. Blocking the sweaters while they dried, instead of drying them in an automatic drier, might

have reduced many of the small amounts of dimensional change.

After 25 days of wear and five launderings the sweaters were still judged acceptable for wear. The Ban-lon and Tycora sweaters were rated higher than the Orlon acrylic sweaters as to overall appearance, degree of pilling, dimensional stability, and amount of color change. The Orlon acrylic sweater, however, had fewer snags as a result of wearing and laundering. Laundering affected the dimensional stability and color, while wearing affected the amount of snagging and pilling and overall appearance.